



## LEVELS OF ACQUISITION OF SCIENTIFIC LITERACY AMONG SENIOR SECONDARY THREE SCIENCE STUDENTS IN EBONYI STATE, NIGERIA

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### ABSTRACT

*This study looks at the level of scientific literacy possessed by senior secondary three science students in Ebonyi State. Three research questions and three null hypotheses were formulated for the study. The population composed of 3462 SS3 science students from Abakaliki Education Zone. A sample of 346 science students making 10% of the population was selected. The instrument for data collection was a Test of Levels of Scientific Literacy (TOLSL) adapted by the researcher and validated by experts. A reliability estimate of 0.73 was obtained using Kuder Richardson KR-20 formula. Friedman Chi-Square ( $\chi^2$ ) test of the mean and mean rank was used for answering research question 1 and analyzing hypothesis 1. Mann Whitney (U and Z) test was also used for answering research questions 2 and 3 as well as analyzing hypotheses 2 and 3. It was found that the SS 3 science students possessed more of nominal scientific literacy, less of functional and least of structural scientific literacy. Gender was significant in the acquisition of scientific literacy because, males possessed more of nominal while females possessed more of functional and structural scientific literacy. Location was also significant as science students in the urban schools possessed more scientific literacy than their counterparts in schools located in the rural areas. It was recommended that science teachers should adopt better methods and strategies for teaching science in order to increase the possession of scientific literacy among students.*

**Key Words:** Acquisition, Scientific Literacy and Science Education.

### INTRODUCTION

We are living in the scientific world and therefore, scientific products have flooded our domestic environment, making life without them difficult. It therefore, presupposes that everybody should be involved in scientific enterprise by doing science. Developed countries like Britain, Japan, United States of America, China, Germany, France, Russia and emerging economies like Malaysia, South Korea and Brazil are making optimal use of their scientific knowledge, in industrial and economic developments. They have adapted



their science to suit their environment, culture and society (Okafor, 2002). They also have strengthened their science and science education; to the extent that, it is able to produce citizens with skills and competences for scientific development.

The case is not the same for Africa and the third world countries like Nigeria. Science which hitherto should be a vehicle for economic and industrial development and should be of premium importance is being relegated. Therefore, this has led to continued under development and the inability of Nigeria to produce scientific products in form of goods and services for export. It is also because science and science education in Nigeria is not functional, to the extent of producing citizens with scientific literacy, needed life skills and competences for scientific, industrial and economic developments of the nation (Saleh & Faki, 2011). Nwagbo, (2002), opined that the science education in Nigeria to a large extent has failed to produce citizens capable of acquiring skills and competences to be independent scientifically. Science education in our schools must be strengthened in order to produce citizens adequately equipped to take decisions in their daily lives. One of the major goals of science education is the inculcation of scientific literacy (Mbajorgu, 2003; Nwagbo, 2006). Therefore, for our science education to be able to lead to technological advancement, it must pursue the goals of inculcating scientific literacy, because the economic development of any nation depends largely on the level of scientific literacy possessed by citizens of that nation (Njoku, 2002; Nwagbo, 2006).

Nwagbo, (2006); Saleh & Faki, (2011) noted that scientific literacy is the ability of the individual to understand and appreciate the nature of scientific knowledge and the application of such knowledge in decision making and problem solving. Okoro, (2000) defined scientific literacy as the ability to utilize creatively science knowledge in everyday life, to solve problems, make informed decision and function well in the society. The understanding of the scientific principles and the appreciation of nature of scientific knowledge must lead to the acquisition of scientific skills at the (intellectual, attitudinal, societal and interdisciplinary levels) and the possession of scientific literacy. Based on these the researchers noted that scientific literacy is the ability of an individual to possess functional knowledge, attitude, skills, core values and competences of science, use of scientific method as well as their ability to apply them for independent life, and lifelong education.

Furthermore, scientific literacy involves the inculcation of science, technology and mathematics (Besong, 2002; Nwagbo, 2006), which will create in the population scientific consciousness, especially in knowing the nature of science, science content, developing activities of science, create materials that will make them independent and productive (Njoku, 2002; Saleh and Faki 2011; Njoku, 2002). Therefore, the individual must possess the ability to be independent, reasonable, creative and contribute to the general well-being of the society.

According to Shamos, (1985) quoted in Langksh, (2000) suggested three levels of scientific literacy. These include practical scientific literacy, civic scientific literacy and cultural scientific literacy. The author further suggests that these levels are not only being



mutually exclusive but also distinct with respect to objective, audience, contents, format, and means of delivery. Okoro, (2000) quoting Hillbrook and Rannikmae (1977) who cited BSCS, (1973) divided comprehensively scientific literacy into four distinct and comprehensive levels which includes, nominal, functional, structural and multi dimensional levels of scientific literacy. Out of the four distinct levels, this paper dealt with three of the scientific literacy levels because these are the three levels expected that senior secondary 3 science students would attain after secondary education. The three levels are:-

Nominal/cultural scientific literacy;- this is where students are able to identify terms, concepts as being scientific in nature, but with misconceptions.

Functional scientific literacy; - In this case students can describe concepts but have limited understanding of it.

Structural Scientific literacy; - where students develop personal relevance and interest in science. Construct appropriate meaning of science concepts from experiences.

It is believed that science students are supposed to gain competence in science content and the nature of science, as they possess scientific literacy not only at the nominal, functional level but also at structural level because students in their final year or SS3 have fully developed personal relevance and interest in science and can construct meanings of science concepts from their experiences. It is therefore, mandatory for every secondary school science students to possess scientific literacy up to functional and even structural levels. Some studies, Nwagbo, (2006) & Babalola, (2013), indicate that students' acquisition of scientific literacy may differ between male and female students or between urban and rural schools. This necessitates the inclusion of gender and school location as factors in this study.

Gender is a physiological and social difference of being either a male or female. Gender may be regarded as a major factor in acquisition of scientific literacy. This is because most female students tend to avoid science subjects more than the male students in the secondary schools (Mbajorgu, 2003). This may affect female students' performance in science and consequently the extent to which they become scientifically literate. This can also be evidenced in students' admission into science related subjects in the tertiary institutions (Njoku, 2002). Nwagbo, (2002) indicated that gender is a factor in the acquisition of scientific literacy in Nsukka education zone. Supporting the above assertion, Mbajorgu, (2003) observed that science concepts, structure and methodology eschew feminine attributes like subjectivity, intuitiveness; leading to alienation and fear of science by the feminine gender. Apart from gender, location is also an important factor in the assessment of students' level of scientific literacy

Location can be described as the environment in which a school is situated. It may be of urban environment or rural environment. The location of students may affect their



acquisition of scientific literacy. In schools located either in the rural or urban areas; students may be affected by the environment (Ali, 2006). To this effect, the level of scientific literacy a student possesses may be dependent upon other factors which affect the location of the schools, like culture of the people, world view, prior or alternate conceptions and teacher quality (Eze, 1999). Students in urban areas, who use certain technology like electronic devices, may possess more science knowledge; have better opportunities of interacting with scientific products than their counterparts in the rural areas. This is because most schools in the rural areas experience more of irregular electricity and have very few science facilities. These students are likely going to interact with fewer gadgets and this could affect their level of acquisition of scientific literacy.

Scientific literacy is one of the major goals of science education. The level of acquisition of scientific literacy depends on the level of science education taught in schools. Due to the way in which science education is being taught in our schools there may be a low level of scientific literacy. The low level of acquisition of scientific literacy simply indicates non functionality of science education and that students have failed to acquire scientific knowledge, attitude and skills to produce goods and services. As a result students leave school and yet may not be too competent to what scientific literates needed to do in the society. A problem therefore exists and most science education researchers began to question the curriculum content, teaching methods and all facets of the science education system. This led to this study which is to assess the levels of scientific literacy possessed by graduating SS3 students of Abakaliki Zone of Ebonyi State.

### **PURPOSE OF THE STUDY**

In line with problems of the study, the study investigates the level of nominal, functional and structural levels of scientific literacy possessed by SS3 science students in Abakaliki Education zone of Ebonyi state. Specifically, the study sought to determine the:

1. Levels of scientific literacy possessed by secondary school science students.
2. Influence of gender on the level of nominal, functional and structural scientific literacy possessed by secondary school students.
3. Influence of location on science students' possession of nominal, functional and structural scientific literacy.

### **RESEARCH QUESTIONS**

The following research questions guided the study:

1. What is the level of nominal, functional and structural scientific literacy possessed by SS3 science students in Ebonyi state?
2. What is the influence of gender on the nominal, functional and structural scientific literacy possessed by science students in Ebonyi State?
3. What is the influence of school location on nominal, functional and structural scientific literacy possessed by science students?



## **HYPOTHESES**

The following null hypotheses tested at .05 level of significance were formulated for the study:

- H<sub>01</sub>: There is no statistical significant difference in the mean score of SS3 science students to their level of nominal, functional and structural scientific literacy as measured by TOLSL.
- H<sub>02</sub>: There is no significant difference in the mean score of male and female SS3 students on nominal, functional and structural levels of scientific literacy as measured by TOLSL.
- H<sub>03</sub>: There is no significant difference in the nominal, functional and structural levels of scientific literacy possessed by urban and rural SS3 students as measured by TOLSL.

## **METHOD**

The design for this study was an ex-post factor research design. Ex-post facto is a design that examines past occurrences in order to understand current state of events without the manipulation of the independent variables (APA, 2020). This design suits this study because data for the study was obtained from students' scores of an existing instrument. The area of the study is Abakaliki Education Zone of Ebonyi state and Abakaliki Education zone is one of the three education zones in Ebonyi state, comprising of 36 urban and 29 rural secondary schools selected for the study. The population was made up of all the 3,462 science students in SS 3 from 65 secondary schools in Abakaliki Education zone, comprising 1,382 females and 2,080 male students (Ebonyi State Secondary Education Board, 2011). The study made use of 346 as the sample size. A multi stage random sampling process was used to select the sample size. Out of the four education zones in Ebonyi state, Abakaliki education zone was selected using purposive sampling technique because, it has urban and rural schools. The researcher purposively classified the schools into school types and selected three co-educational schools from each of the four local government areas of Abakaliki, Ebonyi, Izzi and Ohaukwu. This made up six coeducational schools from the urban and rural areas making a total of 12 schools. All the students in the twelve schools selected were used as sample size for the study. The instrument used for data collection was Test of Levels of Scientific Literacy (TOLSL) adopted by the researcher from Aikenhead's 'View on the Science and Technology Society Approach' (VOSTSA). For science content and a test of scientific literacy scale constructed by Richard Carrier on Internet Fidel test of scientific literacy, for nature of science were used. The two tests was joined together to make up the TOLSL. The instrument was made up of 45 items where 30 addressed science content and 15 items addressing nature of science. The three levels of scientific literacy were addressed by 10 questions each for science content for each of the levels of scientific literacy and 5 question items each addressed nature of science in each of the three levels of scientific literacy under study. Each student was scored in a proportion of correct scores out of 30 and 15



items. The researchers carried out face validation of the instrument using experts in science and measurement and evaluation from the department of science education of University of Nigeria Nsukka. The validation was based on language level, clarity, whether the instrument addressed the content of science as well as nature of science in relation to nominal, functional and structural levels of scientific literacy. Using 40 SS3 science students from a coeducational school in Udi L.G.A, which is similar to the study area as it is semi urban. Kuder- Richardson Reliability Coefficient KR-20 tested at 0.05 level of significance was used to measure internal consistency of the instrument and a reliability estimate of 0.73 was obtained, showing that the instrument is reliable. Friedman Chi-Square ( $\chi^2$ ) test of the mean and mean rank was used for answering research question 1 and analyzing hypothesis 1. Mann Whitney (U and Z) test was also used for answering research questions 2 and 3 as well as analyzing hypotheses 2 and 3. The Friedman Chi-Square ( $\chi^2$ ) test was used because after ranking the mean, it will serve to test the levels which is three levels and chi-square compares three items. Man Whitney U and Z was used to test the three variables in relation to the three variables in two places for two items of the levels of functional and structural levels of scientific literacy.

## RESULTS

### Research Question 1

What is the level of nominal, functional and structural scientific literacy possessed by SS3 science students in Ebonyi state?

**Table 1: Friedman ( $\chi^2$ ) test of the mean and mean rank of the level of nominal, functional and structural scientific literacy possessed by SS3 science students in Ebonyi state**

| Levels     | N   | Mean | SD   | Mean Rank | $\chi^2$ | Sig  | Dec |
|------------|-----|------|------|-----------|----------|------|-----|
| Nominal    | 346 | 8.91 | 2.18 | 2.67      | 322.48   | 0.00 | S   |
| Functional | 346 | 7.04 | 1.93 | 1.88      |          |      |     |
| Structural | 346 | 6.24 | 1.49 | 1.45      |          |      |     |

Table 1 shows the mean values for nominal, functional and structural scientific literacy possessed by the students. The mean ranks for the three levels of scientific literacy were shown. The mean values and rank indicate that the scientific literacy of the students was highest for nominal, followed by functional and structural scientific literacy. Therefore, the students possessed all the levels of scientific literacy in an ascending degree of high, mid and low levels.

### Research Question 2:

What is the influence of gender on nominal, functional and structural scientific literacy possessed by SS3 science students in Ebonyi state?



**Table 2: Mean rank of the influence of gender on nominal, functional and structural scientific literacy possessed by SS3 science students in Ebonyi state using Mann Whitney (U) Test**

| Levels     | Gender | N   | Mean Rank | U    | Z     | Sig  | Dec |
|------------|--------|-----|-----------|------|-------|------|-----|
| Nominal    | Male   | 208 | 176.68    | 1.37 | -0.74 | 0.46 | NS  |
|            | Female | 138 | 168.71    |      |       |      |     |
| Functional | Male   | 208 | 170.56    | 1.37 | -0.69 | 0.49 | NS  |
|            | Female | 138 | 177.93    |      |       |      |     |
| Structural | Male   | 208 | 167.52    | 1.31 | -1.45 | 0.15 | NS  |
|            | Female | 138 | 182.51    |      |       |      |     |

Tables 2, shows the mean rank of male and female students Nominal, Functional and Structural scientific literacy. The influence of gender on levels of scientific literacy possessed by the students was predominant for male students in nominal scientific literacy which is high. This is because the male students had the highest mean rank when compared with their female counterparts in nominal level of scientific literacy than functional. It was equally observed from Table 2 that the influence of gender on the three levels of scientific literacy possessed by the students was more predominant and higher for female students in functional and structural scientific literacy. This is because the female students have the highest mean rank when compared with their male counterparts in these levels.

### **Research Question 3:**

What is the influence of location on nominal, functional and structural scientific literacy possessed by SS3 science students in Ebonyi state?

**Table 3: Mean rank of the influence of location on nominal, functional and structural scientific literacy possessed by SS3 science students in Ebonyi state using Mann Whitney U and Z Test**

| Levels     | Location | N   | Mean Rank | U    | Z     | Sig  | Dec |
|------------|----------|-----|-----------|------|-------|------|-----|
| Nominal    | Urban    | 194 | 190.36    | 1.15 | -3.60 | 0.00 | S   |
|            | Rural    | 152 | 151.98    |      |       |      |     |
| Functional | Urban    | 194 | 196.58    | 1.03 | -0.47 | 0.00 | S   |
|            | Rural    | 152 | 144.04    |      |       |      |     |
| Structural | Urban    | 194 | 193.43    | 1.07 | -4.43 | 0.00 | S   |
|            | Rural    | 152 | 148.06    |      |       |      |     |





Table 3 indicated the urban and rural students' levels of Nominal, Functional and Structural scientific literacy. The influence of location on the levels of scientific literacy by the students was more predominant for urban students in nominal, functional and structural scientific literacy. This is because the urban students had the highest mean rank when compared with their rural counterparts in all the levels and therefore has higher levels in the three categories

### **Hypothesis 1**

**H0<sub>1</sub>:** There is no statistical significant difference in the mean score of SS3 science students to their level of nominal, functional and structural scientific literacy as measured by TOLSL.

The result in Table 1 equally shows Friedman Chi-square ( $\chi^2$ ) value of 322.48 with associated probability 0.00. The associated probability values 0.00 was less than 0.05 as level of significance, the null hypothesis ( $H_{01}$ ) which stated that there is no significant difference in the mean TOLSL score of the students in SS3 to their level of nominal, functional and structural scientific literacy test was rejected. Therefore, there was a significant difference in the mean TOLSL score of the students to their level of scientific literacy test in favour of nominal scientific literacy, followed by functional and then structural scientific literacy.

### **Hypothesis 2**

**H0<sub>2</sub>:** There is no significant difference in the mean score of male and female SS3 students on nominal, functional and structural levels of scientific literacy as measured by TOLSL.

The result in Table 2 showed the Mann Whitney (U) and Z values with associated probability for the three levels of scientific literacy by male and female SS3 students. The U values for nominal, functional and structural were 1.57, 1.37 and 1.31 respectively. The Z values were -0.74, -0.69 and -1.45 for nominal, functional and structural respectively. The associated probabilities were 0.46, 0.49 and 0.15 for respectively. Since the associated probability values for each level of scientific literacy was greater than 0.05 as level of significance, the null hypothesis ( $H_{02}$ ) which states that there is no significant difference in the mean scores of SS3 science students' levels of scientific literacy, was not rejected. Therefore, there is no significant difference in the mean scores of SS3 science students' on their levels of scientific literacy.

### **Hypothesis 3**

**H0<sub>3</sub>:** There is no significant difference in the mean score of Urban and Rural SS3 students on nominal, functional and structural levels of scientific literacy as measured by TOLSL.





Table 3 shows the U values for the three levels of scientific literacy as 1.15, 1.03 and 1.09 respectively. The Z values were -3.60, -4.97 and -4.43 for the three levels. The associated probabilities were 0.00, 0.00 and 0.00 respectively. Since the associated probability values for each level of scientific literacy was less than 0.05 as level of significance, the null hypothesis ( $H_{03}$ ) which stated that there is no significant difference in the mean score of Urban and Rural SS3 students on nominal, functional and structural levels of scientific literacy as measured by TOLSL was rejected. Therefore there was a significant difference in the three levels of scientific literacy possessed by urban and rural SS3 students as measured by TOLSL, in favour of urban students

## DISCUSSION

The findings of the study showed that SS3 science students in Ebonyi state possessed some levels of scientific literacy. This is in agreement with Saleh and Faki, (2011) who opined that secondary school science student should possess scientific literacy at these levels. The mean values and rank indicate that the scientific literacy of SS3 science students in Ebonyi state is highest for nominal, followed by functional and structural scientific literacy being the least. This is also in agreement with Eze, (1999), Nwagbo, (2006) and Hazeem, (2007) who separately opined that students possess lower levels of scientific literacy more than the higher levels. It also shows that as science content increases in the students there are increment in the level of scientific literacy. SS3 science students in Ebonyi state possessed all the levels of scientific literacy. This is in contradiction to Okoro, (2000), who observed that students in the secondary school possess scientific literacy at the nominal and functional levels only, but do not possess scientific literacy at the structural level.

The influence of gender on nominal, functional and structural scientific literacy possessed by SS3 science students in Ebonyi state was more predominant for male students in nominal scientific literacy. This is because male students had the highest mean rank when compared with their female counterparts in nominal level of scientific literacy. It was equally observed that the influence of gender on the levels of scientific literacy possessed by the students was more predominant for female students in functional and structural scientific literacy. This is because the female students have the highest mean rank when compared with their male counterparts in the two levels. Also in consonance with Njoku, (2002) the results indicated that there is gender disparity in the possession of scientific literacy among non-science students in University of Nigeria Nsukka. Also Nwagbo, (1995) noted that the levels of scientific literacy in Nsukka education zone showed that possession of scientific literacy favours male students. In this present study, while there is gender implication to the levels of scientific literacy, the males show higher level of nominal scientific literacy, while the females possess higher level of functional and structural scientific literacy.

The influence of location on the three levels of scientific literacy possessed by SS3 science students in Ebonyi state was more predominant for urban students in nominal, functional and structural scientific literacy. This is because the urban students had the



highest mean rank when compared with their rural counterparts in all the levels of scientific literacy. The results of this study is in agreement with most scholars especially Eze, (1999), Mbajorgu, (2003) noted that the possession of scientific literacy is in favour of students in the urban areas. Many factors may be responsible for this trend of results which include electricity, electronic devices and other improved infrastructure found in the urban centres which students start to manipulate even at early stages of life, while their counterparts in the rural areas may not have electricity not to talk of electronic devices.

## CONCLUSION

SS3 science students in Ebonyi state possessed all the levels of scientific literacy. The scientific literacy of the students was highest for nominal, followed by functional and structural scientific literacy. There were also deviations in the levels of possession of scientific literacy, this is because while nominal scientific literacy was more prominent among male science students' functional and structural scientific literacy were more prominent among female students. This showed that there is a gender implication in the levels of possession of nominal, functional and structural levels of scientific literacy. The import of this finding was that the female science students possess higher level of science content and more scientific knowledge than the males. The results also showed that students of urban areas possess more scientific literacy than their counterparts in schools located in rural areas.

## RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:-

1. More and qualified science teachers should be recruited into the teaching of science in the secondary schools especially in the rural areas where the challenges of teaching and learning of science are more demanding than in the urban areas.
2. There is need to develop a curriculum of teaching science that will be geared towards the inculcation of the higher levels of scientific literacy so that the male and female students can possess enough scientific knowledge and skills to be scientifically literate.
3. A program should be introduced to create an enabling environment to increase the level scientific knowledge among the males in our secondary schools rather than the present scenario where the females possess more scientific literacy than the males.
4. There should be greater awareness to the school principal to encourage their science teacher to devote more time to teach science through practical lessons and the use of science laboratories in order to increase scientific knowledge and skills of the students.
5. There should be provision of laboratory equipments in the laboratories. This is because no child can be scientifically literate without being exposed to adequate laboratory exercises



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